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Original Research Article

Determination of Cd, Co, Cr, Ni and Pb metals in lipsticks samples by Flame atomic absorption spectrophotometry (FAAS)

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ABSTRACT

The study was conducted this work to analyze levels of toxic metals in lipsticks specifically sold in the Bhopal area. Acid digestion process was used to prepare the samples and to quantify the levels of heavy metals, including Cd, Co, Cr, Ni, and Pb Flame Atomic Absorption Spectrophotometry was used. Calibration curves were prepared with good linearity for accurate measurement of concentrations of these metals. All heavy metal observed were within the allowable limit. To assess the health risks, Average daily dose (ADD) and Hazard quotient (HQ) (Ingestion) for all the lipstick samples were calculated. Among these samples, three samples shows higher values among them one belonged to a branded category, while the remaining two were from the non-branded category. These particular Lipsticks samples exhibited higher HQ values (higher than 1), indicating a probable hazard linked of toxic-metals.

1. Introduction

Cosmetics have been an integral part of body care routines for individuals worldwide, with a massive global market for facial cosmetics and care products. The term "cosmetics" encompasses various formulations used for cleansing, enhancing beauty, and promoting attractiveness, and their use has been on the rise.[1–3]

Lipsticks, in particular, are popular due to their diverse colors achieved through pigments, which can be organic or mineral-based.[4] However, some pigments may contain toxic metals, posing risks to regular consumers. The presence of toxic metals in lipsticks is often linked to the manufacturing process, emphasizing the need for quality control and careful selection of raw materials to ensure consumer safety. Despite stringent controls, toxic metals can still be found in cosmetic formulations.[3,5,6]

Regulatory bodies and manufacturers must collaborate to establish safe levels of toxic metals in cosmetics to ensure consumer health and promote confidence in the cosmetic industry. Despite such efforts, the concern remains due to the extensive use of these products and the potential risks associated with toxic-metal exposure.[1,7,8] The scientific community is increasingly concerned about the safety of cosmetics containing toxic metals, given their extensive use by consumers. These metals, when in direct contact with the body, can be absorbed and form complex protein-metal compounds, leading to various health problems, including cellular damage and adverse health outcomes.[9,10] The exposure to toxic metals in lipsticks can occur through dermal absorption or ingestion, as individuals may unknowingly ingest lip products during daily activities. This unintentional exposure can lead to a range of negative consequences, including behavioral disorders, gastrointestinal issues, skin disorders, organ toxicity, and even potential cancer development.[11]

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In India, data on toxic metals in lip products are insufficient, and risks for consumers have not been extensively studied. So with this background we conduct research to analyze the levels of toxic metals in lipsticks sold in the Bhopal region to ensure consumer safety and well-being.

2. Methodology

2.1. Chemical and reagents

Standards solutions of Cd, Co, Cr, Ni and Pb were procured from Loba Chemie Pvt. Ltd., India. Perchloric Acid and Nitric acid were purchased from Scientific Systems, India. All other chemicals, reagents and solvents used were of analytical grade.

2.2. Collection of samples

20 lipsticks samples were procured from the local market of Bhopal region. These samples comprised of ten branded lipsticks and ten local or non branded lipsticks. The lipsticks selected for this study were of different brand names and price ranges.

2.3. Preparation of samples

For the quantification of toxic-metals such as Cd, Co, Cr, Ni and Pb, acid digestion method was employed. In this method, one gram of each lipstick sample was weighed and transferred to a conical flask. Subsequently, 5 ml of a mixture of acid containing $HClO_4$ and HNO_3 in a ratio of 1:3 was added to the flask. The mixture was then subjected to heating on a heating plate at 100°C for a period of 2 hours. Afterwards, an additional 3ml of the mixture of acid was introduced, and the heating process was repeated for an additional 2 hours to assure complete digestion of the samples. Upon completion, the samples were allowed to cool down to room temperature and then diluted to a final volume of 25 ml using de-ionized water. To eliminate unwanted components, the resulting solution was filtered through whatman filter paper (No.40), yielding a final solution to determine the metals. A control solution prepared in the same manner was used as a reference [12,13].

2.4. Instrumentation

To analyze the metal content, Flame atomic absorption spectrophotometry (FAAS) procedure was employed and an AAS-4141 instrument from ECIL, India was used.

2.5. Preparation of standard curves and quantitative analysis

2 ml volume of a stock solution containing Cr (1000 ppm) was measured using a pipette in to 10 ml volumetric flask and diluted up to mark to obtain a 200 ppm Cr solution. Further dilutions were made from this 200 ppm solution to prepare Cr solutions by pipetting of 0.1 ml, 0.2 ml, 0.3 ml, 0.4 ml and 0.5 ml in to a 100 ml volumetric flask and diluted up to mark using metal-free distilled water to obtain 0.2ppm, 0.4ppm, 0.6ppm, 0.8ppm, and 1ppm solutions.

To analyze the metal content, instrument (AAS-4141, ECIL, India) was optimized using a Cr hollow cathode lamp and an air-acetylene combination as the fuel. The absorbance's of the prepared Cr solutions at level of 0.2ppm, 0.4ppm, 0.6ppm, 0.8ppm, and 1ppm were measured and a standard curve was constructed from the data. Similarly, calibration curves for other metals were prepared using their respective level. Sample solutions were then analyzed for the levels of each metal in sample and data were noted.

2.6. Health risk evaluation

To determine the dose of heavy metal received through ingestion of lipstick, the following equation was used:

Mean daily dose of Ingestion (MDDing) = C ×CF× IR × EF × ED × FI / (AT × BW)

Where C- Concentration of the metal in cosmetic in mg/kg, IR- rate of ingestion (in mg/day), CF- Conversion factor (in kg/mg)x10^{-6}, EF-Frequency of exposure (in events or days /year), ED-Duration of exposure (in years), FI - Fraction of concentration ingested, AT-Averaged time, period of time over which exposure is averaged (in days) and BW Body weight (in kg).

Following the calculation of Mean daily dose of ingestion, a hazard quotient (HQ) was derived to evaluate the non-cancer toxic risk. This was accomplished by dividing the daily dose by a specific reference dose (RefD).

HQ = MDDing. / RefD.

The Mean daily dose of Ingestion and reference dose are utilized as indicators to assess the likelihood of adverse-health-effects. If the Mean daily dose of Ingestion value is below the reference dose, it indicates the absence of adverse-health-effects. Conversely, if the Mean daily dose of Ingestion value exceeds the reference dose, it implies the potential for adverse effects on human health. An hazard quotient value lesser than one signifies the absence of adverse-health-effects, whereas an hazard quotient value above 1 indicates the likelihood of side-effects. [14,15]

3. Results and Discussions

A thorough examination and investigation metals level present in various lipsticks brands was conducted. The components used in the product might be a wide range of materials like mica, silica, or titanium dioxide and may be a source of heavy metals which might be a source of contamination.

Regarding the analytical aspect of the study, three-point standard curves were established for selected metals. These curves showed linearity with correlation coefficients (R^2)

Table 1: Health-risk-assessments for the exposure to Cr, Cd, Co, Pb and Ni in the Lipsticks samples

Sample	Average-daily-dose (ADD)					Hazard-quotient (HQ)				
	Cr	Cd	Co	Pb	Ni	Cr	Cd	Co	Pb	Ni
Mean	0.00002	0.00020	0.00083	0.00257	0.00099	0.00763	0.19894	0.27609	0.73479	0.04931
Median	0.00003	0.00016	0.00048	0.00194	0.00090	0.00880	0.15400	0.15800	0.55375	0.04500

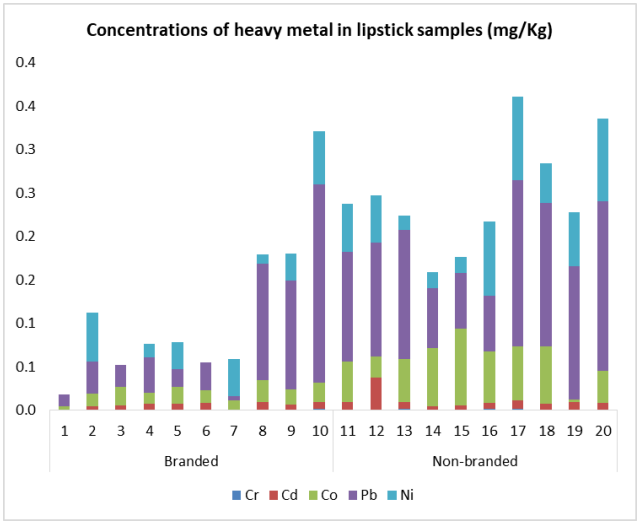

Fig. 1: The centralization of Chromium (Cr), Cadmium (Album), Cobalt (Co), Nickel (Ni) and Lead (Pb) in Lipsticks samples

exceeding 0.99, indicating the reliability and accuracy of measurements.

The level of various metals in the collected lipsticks samples have been compiled and shown in a comprehensive manner in Figure 1.

Overall, the results of the analysis of toxic-metals level in the collected lipsticks samples underline the significance of regulatory measures and quality control practices within the cosmetics industry. The mean values of Cr, Cd, Co, Pb, and Ni in the branded lipsticks samples were 0.0016, 0.0072, 0.016, 30.0661 and 0.0353 ppm whereas median were 0.0016, 0.0076, 0.0161, 0.0345, 0.0307 ppm. The mean values of Cr, Cd, Co, Pb, and Ni in the unbranded lipsticks samples were 0.0011, 0.0105, 0.0504, 0.1308 and 0.0545ppm whereas median were 0.0010, 0.0081, 0.0544, 0.1398 and 0.0549ppm.

The amount of Cr in most branded and non-branded lipsticks samples was not detected except sample one sample of branded category while among non-branded category except 04 samples, others had very low level of Cr. This is partially consistent with the previous report on the level of Cr in cosmetics.[16] The level of Cr obtained in the study are lesser than the values in the other studies. The level of Cd were below 3ppm in both branded and non-branded samples; which set by the US-FDA and Canadian health department.[17]

Pb is found naturally and was detected in all brands of lipsticks samples used in this study; the levels of Pb were found below the permissible limit except one sample of branded and three of non-branded category. The observed levels of Pb in this study found similar with other studies, but still lesser in quantity in comparison.[18–20] Similarly the level of Co and Ni were found lesser the permissible limits. Khalid et al. found Ni level in the range of 0.600-5.947 ppm.[21] According to a critical review conducted by Heppet al., the cosmetic formulations were discovered to have median level of Cr at 3.1 mg/kg, cobalt at 0.91mg/kg, Pb at 0.85mg/kg, and Ni at 2.7mg/kg.[22]

The primary issue with cosmetic formulations is the limited understanding of toxic-metals levels in these formulations and the health related risks for users. Heavy metal are recognized as potential carcinogens. Though, there are challenges in evaluating the cancerous probability specifically related to toxic-metals in lipsticks, as variables for affecting ingestion are currently unavailable in risk evaluation records.

Table 1 presents the essence of the Average-daily-dose and hazard quotient values for all the tested lipsticks samples. The hazard quotient values for Cd and Cr were consistently lesser than one, indicating a negligible non-cancerous risk of these lipsticks samples. The hazard quotient values for Cd ranged from 0.028 to 0.165, while for Cr, the range was from 0.040-0.411. The mean value of Average-daily-dose for Cr, Cd, Co, Pb and Ni of samples were 0.00002, 0.00020, 0.00083, 0.00257 and 0.00099 whereas hazard quotient were 0.00763, 0.19894, 0.27609, 0.73479 and 0.04931. The median value of Average-daily-dose for Cr, Cd, Co, Pb and Ni of samples were 0.00003, 0.00016, 0.00048, 0.00194 and 0.00090 whereas for hazard quotient these were 0.00880, 0.15400, 0.15800, 0.55375 and 0.04500.

4. Conclusion

The study involved the collection of Lipsticks samples from local markets in Bhopal, India, followed by the precise measurement of toxic-metals levels in each sample. After thorough analysis, it was found that, in general, the levels of these toxic-metals in the Lipsticks did not surpass the permissible and found safe.

The chronic non-cancerous health effects because of the ingestion of these Lipsticks was not significant except three samples. Among these samples, one belonged to a branded category, while the remaining two were from the

non-branded category. These particular Lipsticks samples exhibited higher hazard quotient values (higher than 1), indicating a probable hazard linked of toxic-metals.

In essence, the bulk of the Lipsticks samples did not shows a substantial risk, as their toxic-metals level were within safe limits. Though, the increased hazard quotient values in the three non-branded samples highlighted the importance of vigilant evaluation and regulation of cosmetic formulations to assure consumer safety and well-being.

5. Source of Funding

None.

6. Conflict of Interest

None.

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